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Relationship between Economic Growth and Unemployment Rates in the Algerian Economy: Application of Okun's Law during 1991–2019

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Abstract. This paper aims to examine the Algerian economy by applying Okun's law to study the impact of real GDP on unemployment rates and examine the impact of labour market protection policies on Okun's coefficients. The annual data on the Algerian economy for the period 1991–2019 were used. The autoregressive distributed lag (ARDL) bounds testing technique model was used in conjunction with the gap version for Okun's coefficients. The empirical results show that Okun's law operates in Algeria's economy. Coefficients estimated using the gap version led to the conclusion that there was a negative and significant impact of the GDP gap on unemployment rates. Though there was a decline in unemployment as GDP increased, the rise in employment was very weak for each 1% increase in the GDP. These findings should be of significant interest to regulators and policymakers in the Algerian economy, practitioners and academic researchers, international and national investors, managers and any other groups interested in the labour market in the Algerian economy and the labour markets of other developing economies. The paper provides the real GDP's effect on unemployment rates in Algeria by releasing the gap version for Okun's coefficient. Also, it provides evidence that increased labour market protection mitigates the adverse effects of a decrease in output growth rate on employment.

Keywords: unemployment rate, Gross Domestic Product, Okun's law, Algeria economy.

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1. Introduction

When unemployment is low in any economy, the latter evolves, and economic growth rates rise, i.e., there is a strong negative correlation between economic growth rate and unemployment rates, as demonstrated by Okun (1962). Moreover, high unemployment may affect economic growth in a way that is determined by the nature and source of unemployment and its importance to the sectors most affected by economic growth.

The interaction between the unemployment rate and growth rate is the main factor in understanding the phenomenon of unemployment. While formulating economic policies, the focus is on increasing growth rates and not reducing the prevailing unemployment rates, external variables in most standard economic models.

This study aims to confirm the validity of Okun's law in the context of Algeria's economy by testing whether the unemployment rate and GDP growth are linked or not, the strength of this relationship and the direction of correlation. In Okun's words, GDP growth leads to lower unemployment. The growth of the Algerian economy means an increase in real GDP over time. GDP is the value of goods and services produced in an economy adjusted for the change in prices' general level. One of his priorities was to reduce unemployment. Thus, the research problem is encapsulated in the following question: **What was the real GDP effect on unemployment rates in the Algerian economy during 1991–2019?**

One reason for choosing this topic is the lack of studies on this subject in the Arab countries in general and Algeria in particular. Another aim was to assess the effect of several economic reforms initiated to raise the rate of Algeria's economic growth, diversification of the economy, and the development of the labour market and investment. Therefore, the study of the impact of increasing economic growth rates on unemployment rates in the Algerian economy during 1991–2019 using the Okun coefficient is considered a gap in this research.

Algeria was chosen for this study because it is the largest Arab country in terms of area, with large population density, primarily a young population, and because of Algeria's position as the gateway to Africa for the countries of the Mediterranean region. It is also a petroleum exporting country and harnesses other underground resources such as gas, phosphates, and gold. This composition of the country's produce points at the importance of studying its labour market, mainly because studies in this field are few.

This study uses the ARDL bounds testing technique to examine whether Okun's law applies to the Algerian economy during 1991–2019.

The empirical results show that Okun's law operates in the Algerian economy. Coefficients estimated using the gap version revealed a negative and significant impact of the GDP gap on unemployment rates. It was seen that a rise of 1% in the GDP resulted in a weak decline in the unemployment rate, almost zero (0.0000000109%). This was the case with other studies (e.g., Okun, 1962; Prachowny, 1993; Ting & Ling, 2011; Abu, 2017; Soylu et al., 2018).

The paper provides the real GDP and unemployment rates in Algeria and the 'gap version' of Okun's coefficient. Also, it provides evidence that increased labour market protection mitigates negative impacts on economic growth rates.

This study is divided into five parts—the first section provides the introduction, the second section presents literature review and formulates hypotheses, the third introduces the background of Okun's law, and the fourth focuses on methodology. The fifth section provides empirical results, and the last one makes a conclusion and discusses the implications, limitations, and the possible directions of future research.

2. Literature Review and Hypotheses

2.1 Literature Review

Several studies show a causal relationship, as per the concept of Granger causality, between economic growth rate and unemployment rate. However, the theoretical analysis does not always confirm this relationship because it focuses on unemployment as an economic phenomenon caused by an imbalance in economic policies. The first study conducted by Okun (1962) on the US economy analyzed the relationship between GNP and unemployment rates during the period 1947–1960. Okun concluded that each 1% increase in GNP leads to a 0.3% lower unemployment rate. The following studies attempted to confirm this relationship. Some of them applied the Okun law to the regional groupings (of provinces or states) within the same countries or to a group of countries. Most concluded a discrepancy in the Okun transactions (Durech, Minea, Mustea & Slusna, 2014; Adanu, 2005).

In contrast, there were no significant differences between Okun's operations within regional groupings as found, among others, by Villaverd and Maza (2009) in Spain and Rizitiz and Apergis (2003) in Greece. The study by Roa, Vazquez and Saura (2008) confirmed that unemployment and per capita income fluctuated during successive periods. A study by Economou and Psarianos (2016) also confirmed that Okun's Law is robust to fit alternative specifications. The effect of output changes on unemployment rates is weaker for countries that spend higher amounts on labour market protection; it is more persistent in countries with low labour market protection. The study by Ball, Jalles, and Loungani (2015) confirmed that the variation in the Okun coefficients in most countries is due to the specific characteristics of national employment and is not related to labour protection legislation. Guisinger, Hernandez-Murillo, Owyang and Sinclair (2018) used detailed Okun parameters for each state in the United States by introducing variables (e.g., educational level, the level of housing achieved, low membership of labour unions, and non-productive sectors) that were neglected in previous studies and confirmed Okun's law. Bartolucci, Choudhry, Marelli and Signorelli (2011) applied Okun's law to a group of countries and focused on the financial crisis. They concluded that there were additional effects of certain types of financial crises on

the unemployment rate. However, some studies have shown that Okun's law is weak; Valadkhani and Smyth (2015) showed more evidence of the weakness of Okun's law in their study of the economic recession between 1981-1982 and the global financial crisis. At the level of the Arab countries, Ben-Salha and Mrabet (2019) studied North African countries where the Okun factors were estimated by taking into account the possible presence of structural breaks, thresholds and inconsistencies, and highlighted the fact that there is a difference in the Okun's law in terms of gender and age groups in the countries of the study.

The current study makes a contribution that is distinct from its predecessors because it is concerned with the application of Okun's law in the Algerian economy, which is a developing country that has a significant density of population and a large young population and is considered as the gateway to the continent of Africa for the Mediterranean countries. It is also an addition to the studies concerned with the labour market.

2.2 Hypotheses

We propose a set of hypotheses to solve the research problem, and we explain the hypotheses as follows:

H1: There is a negative relationship between economic growth rates and unemployment rates in the Algerian economy.

H2: The economic policies adopted by Algeria hurt unemployment rates.

H3: The policies in Algeria have a positive impact on economic growth.

3. Background

3.1 Economic growth and unemployment

From the era of Adam Smith until Keynes, economic thought was preoccupied with economic growth. The majority of economic thinkers tried to reach the driving forces for it during this historical period. Their ideas were influenced by the economic and social conditions that prevailed in their era. Islam (2004) has confirmed that developing countries can benefit from such new growth implications as the possibility of policy influence on the long-term growth rate, the importance of technological diffusion in convergence, the distinct role of institutions in growth, and potency of trade growth. Recent growth has also led to a re-examination of cross-country implications of the new classic growth theory (NCGT), revealing that, when unencumbered from unwarranted assumptions, NCGT can be more helpful in understanding the growth regularities across developing countries. Corruption, the regulative setting, size shadow economy, mortality rate, financial gain, and inflation affect economic growth. On the other hand, there is a robust positive relationship between the judiciary's standard, education accomplishment, anticipation and economic growth (Cigu et al., 2019).

Moreover, employment is considered one of the primary objectives of economic policies, and economic growth is seen as a means to create jobs and reduce unemployment rates. The relationship between economic growth and employment is complex, especially since its analysis lacks theoretical foundations. The developing countries have an essential role in promoting employment levels by giving job opportunities provided by developing countries' economies. Also, many job opportunities may arise, which are achieved due to supporting local and foreign investment (Matandare, 2018).

Moreover, the link between the economy's growth and unemployment level has been modelled in a nonlinear manner, contrary to the original linear postulation. The Okun relationship has been different during the business cycle, mutated over time and across nations (Onakoya & Seyingbo, 2020).

3.2 *Okun's Law*

Okun (1962) proved the existence of a negative relationship between unemployment and output and focused on three issues that we mention.

3.2.1 *The Gap Version*

In this version, Okun (1962) focused on the difference between unemployment and the natural unemployment rate as the dependent variable and the difference between the actual output and the potential output as the independent variable. He explained the relationship as follows:

$$(U_t - U_t^*) = \beta(Y_t - Y_t^*) + \varepsilon_t \quad (1)$$

where U_t is an unemployment rate, Y_t is actual output, U^* is a natural rate of unemployment, Y^* is a potential output, ε_t is an error term in period t , and β is the Okun coefficient.

3.2.2 *The Difference Version*

Okun's first relationship captured how changes in the unemployment rate from one quarter to the next moved quarterly growth in actual output (Knotek, 2007). The following equation expresses this relationship:

$$(U_t - U_{t-1}) = \beta_0 + \beta_1(Y_t - Y_{t-1}) + \varepsilon_t \quad (2)$$

$$\Delta U_t = \beta_0 + \beta_1 * \Delta Y_t + \varepsilon_t \quad (2.1)$$

where ΔU_t represents the changes in the unemployment rate between the current and previous period. Y_t is the growth rate of output (GDP) in per cent between the current and previous period. ε_t is the error term in period t , and β_1 is Okun's coefficient.

This relationship captures the contemporaneous correlation between output growth and movements in unemployment – that is, how output growth varies simultaneously with changes in the unemployment rate (Knotek, 2007).

3.2.3 The Dynamic Version

One of Okun's observations suggested that both past and current output can impact the current unemployment level (Knotek, 2007). It is called the dynamic model:

$$\Delta U_t = \beta_0 + \beta_1 * Y_t + \beta_2 * Y_{t-1} + \beta_3 * Y_{t-2} + \beta_4 * \Delta U_{t-1} + \beta_5 * \Delta U_{t-2} + \varepsilon_t \quad (3)$$

where U_t is the unemployment rate in period t , Y_t is the GDP growth in period t , Y_{t-1} is the output level at period $t-1$, Y_{t-2} is the output level at period $t-2$, ΔU_{t-1} is the unemployment at period $t-1$, ΔU_{t-2} is the unemployment at period $t-2$, $\beta_1 \beta_2 \beta_3 \beta_4 \beta_5$ are Okun's coefficients, β_0 is the intercept term, and ε_t is the error term in period t .

The most existing literature focuses on Okun's coefficient, without studying the adjustable nature of this relationship's linear nature underlining this challenge.

3.3 Trend Analysis of Unemployment and Economic Growth

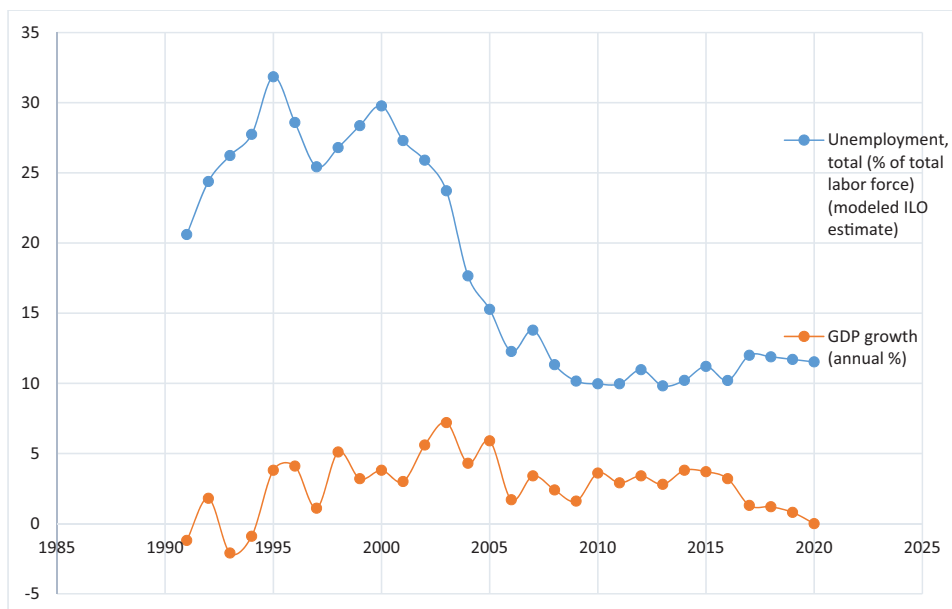


FIGURE 1. GDP growth and changes in unemployment rates (1991–2019).

Source: World Development Indicators

Figure 1 shows that the economic growth rates between 1991 and 2019 witnessed a fluctuation and took their highest value in 2003, where the growth rate reached 7.2 per cent,

and it took its lowest value in 1993 with a negative value of -2.1 per cent and -0.9 per cent in 2004. After the year 1995, growth rates went out of negative values, after the political crisis began to ease, and after the year 2000, oil prices began to rise. Algeria witnessed a moderate economic stability, which contributed to an increase in economic growth rates. However, it did not reach the desired levels compared to government spending during that period due to financial and administrative corruption in most sectors.

As for the labour market level in 2020, the number of unemployed in the world totaled 190.3 million (International Labour Organization, 2020). The global rate of unemployment amounted to 5.42 per cent. Not much had changed from 2019 when it was 5.4 per cent. So some critical disparities across regions concerning unemployment levels have to be highlighted. Perhaps the most important thing to note is that the highest unemployment rate was observed in Algeria in 1995, when it exceeded 30 per cent. Unemployment trends declined during the study period, especially since 2000. This period witnessed a rise in oil prices, which explains most economic growth, and unemployment rates resumed slightly after 2017, which witnessed a collapse in oil. Figure 1 shows the GDP growth and changes in unemployment rates from 1991 to 2019.

4. Methodology

In this study, we used an empirical estimation of Okun's law in the Algerian economy during the period 1991–2019.

4.1 Data

All variables used in this study, the data on the Algeria economy and the time-series component (1991–2019), were taken from the world bank database for all the variables during the period selected for the study. The variables are summarized in Table 1.

TABLE 1. Variables used by Okun's Law

Variable	Proxy	Data source
Unemployment	U_t	WDI Database
Real GDP	GDP_t	WDI Database

Source: Created by researchers

4.2 Model Specification and Estimation Technique

In this part, we estimate the gap version in light of the statistics available to us. Moreover, we use the ARDL bounds testing technique model because the time series of the unemployment gap is non-stationary at a level $I(0)$ and stationary in the first difference $I(1)$. In contrast, the time series of the output gap is stationary at level $I(0)$. The first regression equation of this empirical study is:

$$Ugap_t = \beta_0 + \beta_1 * Ygap_t + \varepsilon_t \quad (1.1)$$

where $Ugap_t = (U_t - U_t^*)$: U_t is an unemployment rate, U^* a natural rate of unemployment. Moreover, $Ygap_t = (Y_t - Y_t^*)$: Y_t is actual output, Y^* is a potential output, ε_t is an error term in period t , and β is the Okun coefficient.

Using the ARDL model, the equation takes the following form:

$$Ugap_t = \beta_0 + \beta_1 * Ugap_{t-1} + \beta_2 * Ygap_{t-1} + \sum_{i=1}^p \gamma_{1i} * Ugap_{t-1} + \sum_{j=1}^q \gamma_{2j} * \Delta Ygap_{t-1} + \varepsilon_t \quad (1.2)$$

5. Empirical Results

To estimate the parameters for Equation 1.2, the stability of the time series should be studied. Then the model should be tested and the obtained result explained by following the steps below.

5.1 Unit Root Tests

Table 2 shows the results of the study variables integration tests using the Augmented Dickey-Fuller test (ADF) for the unit root. The results show that the dependent variable ($Ugap$) is integrated t I at level $I(0)$, while the independent variable ($Ygap$) is integrated into the first level $I(1)$. As a result, the ARDL bounds testing procedure can be adapted to estimate our model.

TABLE 2. Unit Root Tests results (ADF)

		Ugap	Ygap
At level	prob	0.0145	-
	t-stat	-2.51**	-
at 1 st difference	prob	-	0.0185
	t-stat	-	-2.98**
Order of Integration		I(1)	I(0)

Note: ** indicates rejection of null hypothesis at 5%. Source: Output of EViews 10.

5.2 Bounds Tests for Co-integration

ARDL bounds testing approach is a co-integration method developed by Pesaran et al. (2001) to test the long-run relationship between the variables. It is applied in the case of time series stable at the level $I(0)$ or integral at the first difference $I(1)$, or a mixture of the two, provided that it is not integral at the second difference $I(2)$. Table 3 shows the statistical results of the ARDL bounds test attached to the model. The calculated F statistic is estimated at 27.81, which is higher than the critical value bounds related to the upper limit of 1% of importance and estimated at 5.58, thus accepting the null

hypothesis, indicating the long-run no co-integration relationship between the two variables.

TABLE 3. **Computed F-statistic for Co-integration tests – ARDL Bounds tests**

	Model	Conclusion
Lower-upper bound (10%)	3.02-3.51	Co-integration
Lower-upper bound (5%)	3.62-4.16	Co-integration
Lower-upper bound (1%)	4.94-5.58	Co-integration
F-statistics	27.81	
K	1	

Note: K represents the number of regressors included in the models. Source: Output of EViews 10.

5.3 Estimation

The ARDL model distinguishes between short and long-term results, and by estimating the model parameters, we get the following results.

5.3.1 The Global Estimation Findings

According to Table 4, the estimated coefficient of the unemployment gap in the last year is negatively related to the unemployment gap this year at a 5 per cent significance level in the model, and $Y_{gap,t-1}$ is negatively and significantly related to the unemployment gap at 1 per cent significance level. In comparison, the difference between $Y_{gap,t-1}$ and $Y_{gap,t-2}$ is positively and significantly related to the unemployment gap at a 5 per cent significance level. However, the difference in $Y_{gap,t}$ appears to be nonsignificant.

TABLE 4. **Estimate equation of ARDL bounds test model**

Variable	Coefficient	Prob
UGAP(-1)	2.303306***	0.0000
UGAP(-2)	-1.953719***	0.0000
UGAP(-3)	0.615707***	0.0000
YGAP	-2.98E-11	0.8746
YGAP(-1)	-9.15E-10	0.1956
YGAP(-2)	2.60E-09	0.0168
YGAP(-3)	(-2.68E-09)***	0.0011
YGAP(-4)	(1.03E-09)***	0.0001
C	1.477977***	0.0002

Note: *** denotes statistical significance at 1 %. Source: Output of Eviews 10.

5.3.2 The Long-Run Estimation Findings

Table 5 shows the long-run results of Okun's coefficient in Algeria during the period 1991–2019; the immediate impact of changes in the output gap is negative and significant at the 10 per cent level. It means a 1% decrease in the output gap will increase the unemployment rate by 0.053 per cent. These results are supported by Ting and Ling (2011).

TABLE 5. Long-run coefficients estimation with the ARDL Bounds test model

Variable	Coefficient	Prob.
Intercept	1.477976*	0.0002
UGAP(-1)*	-0.034705*	0.0003
OUTPUTGAP(-1)	3.77E-12*	0.0091
D(UGAP(-1))	1.338012*	0.0000
D(UGAP(-2))	-0.615708*	0.0000
D(YGAP)	-2.98E-11	0.8746
D(YGAP(-1))	-9.49E-10***	0.0734
D(YGAP(-2))	1.65E-09*	0.0037
D(YGAP(-3))	-1.03E-09*	0.0001
Case 2: Restricted Constant and No Trend		
Variable	Coefficient	Prob.
YGAP	1.09E-10***	0.0531
C	42.58659*	0.0000
$EC = UGAP - (0.0000*YGAP + 42.5866)$		

Note: * denotes statistical significance at 1 %, *** denotes statistical significance at 10%. The dependent variable is Ugap. Source: Output of EViews 10.

TABLE 6. Long-Run Relationship: Computed F-statistic for Co-integration tests – ARDL Bounds tests

	Model		Conclusion
	I(0)	I(1)	
Lower-upper bound (10%)	3.02	3.51	Co-integration
Lower-upper bound (5%)	3.62	4.16	
Lower-upper bound (1%)	4.95	5.58	
F-statistics	27.81*		
P-value	0.053		
K	1		

Note: * denotes statistical significance at 10 %. K represents the number of regressors included in the models. Source: Output of EViews 10.

Table 6 below represents the longitudinal methodology results for the long-run relationship. We note that the statistic F-fisher calculator is the largest of all critical values either at a level I (0) or the first difference I(1). It indicates the existence of a co-integration relationship between the two variables. Thus, we say that there is a long-run equilibrium relationship between the GDP and unemployment rates in the Algerian economy, and this is consistent with the findings of Abu (2017) and Ting and Ling (2011).

5.3.3 Estimation Error Correction Model (ECM-ARDL)

Since there is a co-integration in the long-run, we performed error correction model (ECM) tests. Table 7 shows its results in the short run. The findings reveal that the speed of adjustment is negative (-0.034), significant at 1 per cent, and does not exceed one's value, hence the validity of the long-run equilibrium mechanism (Pesaran et al., 1999). It means that the annual rate of adjustment toward complete equilibrium in the long run increased by 3.4% in the model.

Thus, Okun's law applies to the Algerian economy in the short term and not in the long run, i.e., with the improvement in the GDP by 1%, the unemployment rate decreases but at a meagre rate of almost 0.0000000109%.

TABLE 7. ECM Regression of ARDL (3,4) Bounds test model

Variables	Coeff.	p-value
$\Delta U_{gap_{t-1}}$	-1.33***	0.000
$\Delta U_{gap_{t-2}}$	-0.61***	0.000
ΔY_{gap_t}	-2.98E-11	0.78
$\Delta Y_{gap_{t-1}}$	(-9.49E-10)***	0.0096
$\Delta Y_{gap_{t-2}}$	(1.65E-09)***	0.0004
$\Delta Y_{gap_{t-3}}$	(-1.03E-09)***	0.000
ECT_{t-1}	-0.034***	0.000

Note: *** denotes statistical significance at 1 %. Source: Output of EViews 10.

5.4 Diagnostic and Stability Tests

After diagnosing the estimated model by the dynamic ARDL method using residual diagnostics, we summarize the results in Table 8.

The results show that the model is free from problems related to serial correlation and heteroskedasticity. Moreover, the functional form by Jarque-Bera normality tests is confirmed. The value of adjusted R^2 is about 99% in the model.

The stability of the estimated coefficients in the model is also proved using recursive residuals (+/- 2 SE) and the cumulative sum of squares (CUSMUSQ) stability tests, as shown in Figure 2 and Figure 3. Both figures indicate that the estimated models are within the 5% significance line, implying that the estimated coefficients of the model are stable.

TABLE 8. Results of Diagnostic Tests

Diagnostic Tests	Model	
	Value	p-value
Serial Correlation LM	11.73 (2)	0.0015
Heteroscedasticity ARCH	2.05 (4)	0.14
Normality Jaque-Bera	0.99(3)	0.6
Squares of the fitted value	0.81 (15)	0.43
Adj. R ²	0.99	

Note: () is the order of diagnostic test (The lag order). Source: Output of EViews 10.

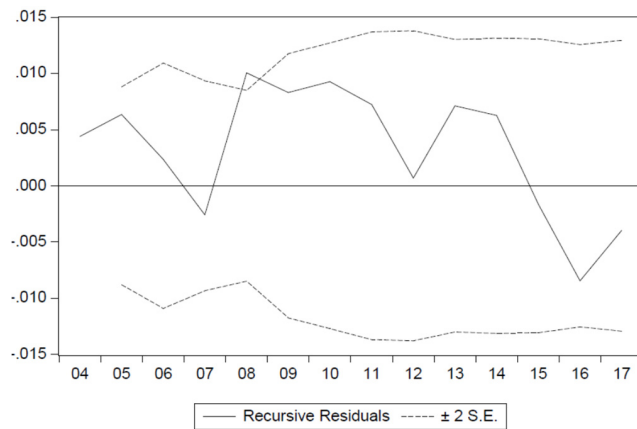


FIGURE 2. Model Stability: Recursive Residuals (+/- 2 SE).

Source: Output of EViews 10.

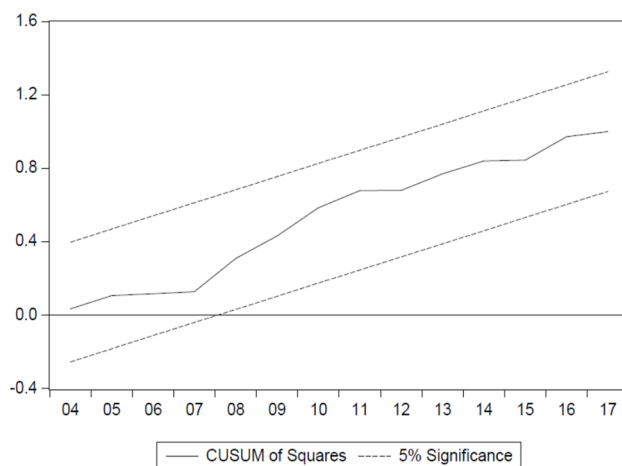


FIGURE 3. Model Stability: Cumulative sum of squares of recursive residuals (CUSUM of squares).

Source: Output of EViews 10.

6. Conclusion and Discussion

This study re-examines the validity of Okun's Law, focusing on the gap version and using the ARDL model in the context of the Algerian economy in 1991–2019. The results obtained from the reality of the available statistics on the Algerian economy indicate that Okun's law holds a negative relationship between the rates of growth of GDP and unemployment rates. A decrease in unemployment rates accompanies every increase in economic growth rates. However, this effect is considered weak compared to other studies (e.g., Binet & Facchini, 2013; Maria et al., 2008; Valadkhani & Smyth, 2015). This is attributable to the Algerian government's policies and economic reforms to revive the economy since 1986, which have failed because they were not adequately implemented, mainly because of the widespread administrative and financial corruption.

The gap version of the Okun coefficients was applied in this study, using the ARDL model. It was found that there is a negative effect in the long and short term. First, for the long term, a negative and significant effect was observed for the change in the output gap for years $t-1$ and year $t-3$, consistent with other studies (Abu, 2017; Ting & Ling, 2011) significant for year t . For year $t-2$, a positive effect was observed, contrary to the expectation and consistent with Ben-Salha and Mrabet (2019) study. This is because the government's policies to revive the economy were delayed in their implementation due to legislative and administrative obstacles, the most important of which was the development of laws and the delay in creating the implementation mechanisms.

Secondly, as for the short term only, the ECT_{t-1} statistic is negative (-0.034) and has a statistical significance at the level of 1%. There is a negative and significant impact of the GDP on unemployment rates in the short term, consistent with the study by Louail and Riache (2019) because the policies applied to revive the Algerian economy gave the labour market importance. However, the lack of control and discipline prevented the continuation of the development of the labour market.

Experimental results indicate that Okun's law holds in the Algerian economy in the short term, but not in the long run. Transactions were estimated using the gap issuance, which resulted in a significant negative gap in the GDP on unemployment rates in the short term and a feeble negative effect in the long run. The GDP rose by 1%, the unemployment rate declined, but by a frail 0.0000000109%, almost zero. These results are supported by Okun (1962), Ting and Ling (2011) and Abu (2017) but are incompatible with the studies by Akram, Hussain, Raza and Masood (2014) and Driouche (2013).

This study's results could help many parties, the most important among them are the decision-makers in Algeria, to reduce the unemployment rate in light of the current developments, economic institutions and business people to contribute to the reduction of unemployment and decision-makers in Arab countries and developing countries, in general, to bring their economies closer to the Algerian economy, especially the oil-exporting states.

One of the most critical shortcomings of this study is the lack of statistics on unemployment rates. We had to rely on the period 1991–2019, which is small and could not address the different version and the dynamic version. Alternatively, the impact of growth rate on the unemployment rate on a cross-section could be studied.

Therefore, we can open the horizons of this research by studying the operation of Okun's law on a group of Arab countries, the Gulf cooperation council (GCC) or the middle east and north Africa (MENA).

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